The road as a quarry…

A case study on the application of recovered aggregate

Road Pavement Forum

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Overview

Case studies

- National Road: N2 upgrade – Cape Town (Borcherd's Quarry)
- (Provincial Main Road: P255 – Durban (between Hillcrest and Waterfall))

Pavement engineering and the water crisis

– approaches for the new normal?

N2 Cape Town – Borcherd's Quarry

- Client: Department of Transport and Public Works, Western Cape Government
- Consulting engineers: HHO
- Laboratory services: SGS

Traditional construction

- 'Waste' generated: **13 000 m^3** of existing concrete pavement, **5 000 m^3** milled asphalt
- About **370 loads** of 35 m^3 container
- Distance site to landfill (total haulage) = **9 000 km**
- Disposal of **28 800 tons** = **R11.5 million** in disposal 'fees'
  - Clean rubble is free but operational costs to City **~ R7.2 million**

N2 Cape Town – Borcherd's Quarry cont.

Reconsidering our resources flows…

Construction material – available at cost of extraction:

- 13 000 m^3 concrete
- 5 000 m^3 asphalt millings

Crushing on-site

36% cost-saving

Unfortunately…. Crushing off-site

20% more expensive than commercial virgin aggregate

*Commercial secondary aggregate – less expensive

N2 Cape Town – Borcherd's Quarry cont.

Material application

From 'old' concrete pavement to C3 sub-base – including RCA and milled asphalt

- crushed to -53 mm
- 100% RCA + 3% cement stabilisation
  - Where sufficient RCA available
  - Testing indicated 2% sufficient
    - 3% as performance buffer

N2 Cape Town – Borcherd's Quarry cont.

Material performance

Specification	RCA	Commercial aggregate
Grading	G5 material produced	G5
Compaction	Easily compacted to 98% modified AASHTO	Not as easily compacted
CBRs	G5 at 95% mod AASHTO > G4 at 98% mod AASHTO	
UCS	4.0-5.0 MPa	1.5-3.0 MPa
ITS	Uniformly high	Often non-compliant
OMC	10-12 %	

N2 Cape Town – Borcherd's Quarry cont.

Key Learnings

Business case

- Very much local market
  - Haulage can break the business case

Processing

- Vital: Stockpile management and QA
- Achieving grading modulus is key
  - GM of 2.6
    - A secondary crusher run is needed to improve grading (lower GM)
    - Could improve CBRs if needed

N2 Cape Town – Borcherd's Quarry cont.

Key Learnings

Material testing

- No decrease in performance re test results
- SANS 3001 test methods to be used
- Was recommended crush to -37 mm for testing
  - But grading should be improved – secondary crush needed
  - Explains variability in sample test results

Application

- RCA have higher OMCs than most gravels
  - NB can compact at 50-60% of OMC
- Asphalt not recommended in mix – lack of cohesion
  - Included as was spoil
  - Can still achieve required performance

Extending the available resources…. (Durban case study)

- 8 000 m^3 concrete re-applied
  - Sourced from the old side drains, kerbs and channelling
  - Applied in
    - Cement-stabilised sub-base
    - Base layer in sidewalks

Reducing water consumption in road construction

Water demand

~200 L per m^3 of road building material

150-200 kL per pavement layer per km

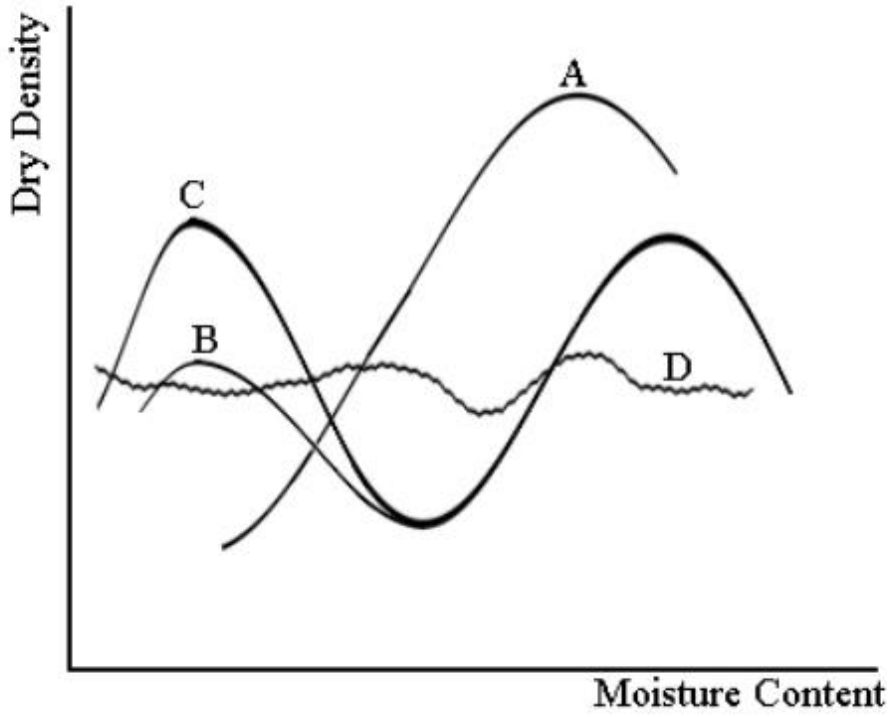
Context-specific evaluation

‘reasonable resource flows’

- Resource availability – eg concrete ‘spoil’ during rehab projects;
  - Rainwater, stormwater capture, low quality water sources
- Resource scarcity – eg water
- Energy costs – eg transport of water, drilling of boreholes, compaction energy

Application	Water Quality Requirements	Approach
Compaction	**'Intermediate'** – Consider receiving environment, low salts	**Improved efficiency**: Consider moisture content of materials **Substitution of potable water/ fresh groundwater**: wastewater
Cement stabilisation	**High** - Approaching potable standards	**Improved efficiency**: Use recycler to mix **Substitution of potable water/ fresh groundwater**: eg wastewater use in readymix
Pressure testing and flushing pipes	Consider receiving environment	**Substitution of potable water/ fresh groundwater**: wastewater
Dust suppression	**'Intermediate'** – Consider receiving environment, low salts	**Substitution of potable water/ fresh groundwater**: wastewater

More attention needed? Reduced water for compaction



Leyland and Paige-Green, 2009

- Not suitable for unsealed roads
- If only in
  - Fill, sub-grade and selected layers
  - = largest volume of material
  - Large water saving
- More work needed
  - Any knowledge of projects or testing?

Thank You

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RecMat feedback - Ian

RecMat

- Recovered materials as pavement construction mayerials
- Committee formed on resolution of RPF May 2016
- Focussing on recovered aggregates (RCA and RCM)

Guideline document:
(list chapters)

RecMat feedback - Ian

Durability testing – performed on commercial virgin aggregate and recovered aggregate (wisdom from RPF needed!)

- Venter test – SANS 3001-AG13 - for comparison and must still comply with COLTO spec of class I or II
- 10% FACT – SANS 3001-AG 10wet – comparative testing and must still comply with COLTO Table 3402/1 which has a min value of 90kN for G5
- 10% FACT wet dry ratio to compare
- Durability Mill Index – SANS 3001- AG16 comparative and % passing 0.425mm sieve must not exceed 35% after DMI test.
- Extended CBR?
- UCS – although for stabilised materials, for RCA and RCM indication of latent cement stabilisation

(triaxial for the future! Requirement of triaxial testing on BSMs to enable future aggregate testing)

Guideline document underpinned by research

National Research Foundation Thuthuka Funded Project Grant: The performance and self-cementing properties of construction demolition waste in roads (Grant Nr: 106968)

Current

- Self-Cementing Mechanisms in Recycled Concrete and Masonry for Road Materials. PhD in Civil Engineering
- Durability and Performance Evaluation of South African Recycled Mixed Granulates in Unbound Pavement Layers. MEng at Delft University of Technology
- The use of Recycled Concrete Aggregate in BSM's. MEng (Research)

Complete

- Modelling the Shrinkage Behaviour of Recycled Concrete Aggregate and Cement Stabilised Materials. MEng (Research), March 2018
- Carbonation of Cement Stabilised Materials in Pavement Layers. MEng (Research), March 2018
- The Performance Properties of Recycled Concrete in Road Pavement Materials. MEng (Research) March 2018
- The Use of Chemical and Strength Tests for Evaluating the Self-cementing Action of Recycled Concrete Aggregate. MEng (Structured), March 2017
- Comparative Shrinkage Properties of Pavement Materials Including Recycled Concrete Aggregates With and Without Cement Stabilisation. MEng (Research). March 2016
- The Influence Of Self Cementation In Recycled Concrete For Road Pavement Materials. MEng (Structured), December 2015
- Material characterisation and response modelling of Recycled Concrete and Masonry in Pavement Layers. MEng (Research), March 2014

Trial sections…

- RecMat as collator and repository of trial sections
  - And previous projects including recovered aggregate
  - Please contact Ian Bowker or Kirsten Barnes
- How to stimulate trial sections?
  - Any possible projects?
- Other case studies to be…
  - N3 Corridor Project KZN
    - HHO and Bvi are involved